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2017

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Application of the Otago Exercise Program in treating Fall Frequency and Fall Risk in an Elderly Patient Living Independently: A Case Report

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Abstract:

Background: Falls are the leading cause of fatal and nonfatal injury occurrence among adults aged 65 years and over. Fall frequency and resultant injuries, loss of independence, and death continue to rise annually. Although literature has determined the top risk factors, and the availability of fall prevention care has become more widespread, the aging population continues to fall with no sign of change. Studies have identified the seven greatest risk factors for falling, and of those seven, few are actually modifiable. When it comes to fall prevention, the most common interventional recommendation to decrease fall frequency is exercise prescription. Physical therapists, as movement experts and direct access providers, have the greatest potential to address the functional deficits faced by aging adults and create individual specific interventions focused on gait, balance, and strength in order to reduce fall frequency. **Case Description**: This case study follows a 79 year old female living at home who underwent a course of outpatient physical therapy after a recent increased fall frequency. **Outcomes**: A total of 15 billable visits resulted in Dynamic Gait Index improvement by 6 points, MiniBESTest balance evaluation improvement by 14 points, and Otago exercise difficulty progression from Level A to D and B to D for strength and balance retraining, respectively. **Discussion**: The purpose of this case study is to present evidence supporting the physical therapist's role in reducing fall frequency and improving independence through application of scientifically supported interventions. Positive change in objective strength and functional improvement may suggest that the application of the Otago Exercise Program (OEP) as part of a multifactorial fall prevention intervention would reduce fall frequency among a wider population.

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Introduction

Falls are the leading cause of fatal and nonfatal injuries among adults over the age of 65 years old.[1, 2] Serious consequences can, and often do, occur following these falls. Such consequences include: trauma, pain, and impaired function, lost confidence carrying out everyday activities, lost independence and autonomy, and death. [1, 2, 3] Frequency of falls and the severity of resulting consequences increases with age. With the Baby Boomer generation at or beyond retirement age, the frequency of falls within the population, along with resulting injuries, medical expenses, and deaths, will likely increase. Fall prevention has become a significant area of research that has brought about fall prevention programs and specific interventions aimed at addressing risk factors in order to reduce fall frequency. What remains to be determined are the most modifiable risk factors, and the best interventions designed to address the deficits which lead to increased fall risk.

Background and Purpose

While the term “fall” at first glance may seem clear, debate exists as to how to best define a “fall” for research and statistical analysis [3, 4]. Throughout this case study, the definition of a fall will be “an event which results in a person coming to rest inadvertently on the ground, floor or other lower level”. [5] This is the definition most often used within research studies, and was originally put out by the Prevention of Falls Network Europe and Outcomes Consensus Group in 2005.

Statistically, one out of every three adults over the age of 65, and one out of every two adults over the age of 80 will fall at least once this year. Injuries resulting in decreased mobility and independence will occur in 20-30% of those falls. [6, 7]

The overwhelming agreement within fall prevention research is that, to reduce an individual’s risk of falling, individuals must eliminate as many risk factors as possible. The top seven risk factors most frequently associated with individual falls are: (1) History of Falls, (2) Vertigo (3) Parkinson’s Disease, (4) Fear of Falling, (5) Gait Problems, (6) Use of Walking Aids, and (7) prescription for antiepileptic drugs[2]. While logical, further assessment of the listed top risk factors reveals that only a few are modifiable to the extent of correction and elimination. Of the modifiable risk factors listed, the healthcare profession most adept to address these deficits are physical therapists.

One of the seven listed risk factors is completely outside the physical therapist’s scope of practice. The American Physical Therapy Association’s published practice act for physical therapy does not allow physical therapists to make recommendations or suggestions regarding patient medications. However, patient advocacy and the evolving team-based healthcare approach to medicine has resulted in increased conversation amongst healthcare practitioners. Therefore, a physical therapist suggesting the review of current medications list for best patient care, would be allowed and encouraged.

The first listed risk factor, history of falls, is unmodifiable once a fall has occurred. The only way to eliminate this risk factor is through the prevention of any initial fall. This can only be done through the modification of the other risk factors.

Remaining risk factors are modifiable through physical therapy. The risk factor that may seem most easily modifiable, the use of an assistive device, is the risk factor requiring greatest clinical rational prior to reversal. Use of assistive device presents multiple associated dangers to the patient including the high variability in device integrity and individualized device fit, device use consistency and efficiency, and the patient’s mental capacity. Sometimes, the patient is improperly trained on how to use the assistive devices, or has developed preferential habits unchangeable by the healthcare professional. In these cases, the device is a liability. However, inappropriate discharge from the assistive device has implications in regard to fear, independence, and safety. The required rehabilitative gains needed prior to discontinued use may not be feasible for some patients. In these cases, the instruction to stop using the assistive device would expose the patient to greater danger than the associated liability from suboptimal device use. Danger such as fear of falling, decreased stability, decreased endurance, increased frequency of sedentary behavior, and perpetual isolation would all constitute the potential for future harm. Therefore, this risk factor is very patient-dependent requiring the clinician to demonstrate critical clinical judgement to make the best decision for patient safety.

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The second and third listed risk factors are vertigo and Parkinson's Disease, both of which present with symptoms that are modifiable with physical therapy and other medical interventions. However, neither diagnosis are curable. Vertigo is an umbrella term often referring to at least one of the three of the following diagnoses: Benign Paroxysmal Positional Vertigo (BPPV), Vestibulopathy, and Meniere 's Disease. Vertigo as a result of mechanical disruption in the semicircular canals results in the diagnosis of BPPV [8]. Physical therapy addresses this diagnosis with canalith repositioning techniques, most often the Epley maneuver. Symptoms can be reversed within one or two interventions, giving the patient significant relief. However, reoccurrence will occur in 30% of the effected population within one year of repositioning treatment and 50% of the effected population within 5 years[9]. Vertigo can be the result of a central deficit of the vestibulocochlear nerve (CNVIII), resulting in varying degrees of unilateral or bilateral vestibulopathy. There is currently no way to correct or reverse damage to cranial nerves. However, vestibular rehabilitation performed by a physical therapist is often the most effective treatment to retrain the dysfunctional central connection between the eyes and ears resulting in successful accommodation[9]. Finally, vertigo can be a debilitating symptom occurring in patients diagnosed with Meniere's Disease. Meniere's disease can be treated with medication, however medication is often used in conjunction with vestibular rehabilitation for accommodation[10, 11]. This intervention would be similar to the rehabilitation completed for vestibulopathy diagnosis.

Parkinson's Disease, defined as a neurodegenerative disease affecting volitional and purposeful movement occurs secondary to the loss of dopamine-producing brain cells within pars compacta (SNc), part of the substantia nigra located in the basal ganglia[12]. Similar to Meneire's Disease, Parkinson's Disease can be treated through a variety of medical interventions, operatively or with prescription medication. However, the progressive effects are not reversible, and neurological physical therapy the most common strategy used to maintain functional independence[11].

Fear of falling is a significant problem within the aging community leading to isolation[13]. Adults may fear previously common activities such as grocery shopping. These previously simple tasks become another area of lost independence, potentially resulting in depression and lack of desire to pursue interests. The consequence of these lost opportunities for activity can lead to muscle weakness and fragility, further perpetuating the risk of fall. Physical therapy interventions including strengthening, balance, and practice of functional activity completion in a safe environment are the best way to reduce the fear of falling. Although potentially never enough to eliminate fear, this care helps prevent the previously mentioned isolation, depression, weakness, and fragility.

The final, most modifiable risk factor associated with falls is gait problems. Physical Therapists have the greatest background to analyze gait deficits and train corrected movement patterns via strengthening, balance, coordination, and neuromuscular reeducation.[1, 3, 7, 6, 14, 15,16] While none of the listed risk factors can be eliminated, gait problems exist as the most easily modifiable and directly impacted by existing physical therapy interventions. Additionally, addressing this risk factor is the best way to prevent the patient's first fall, successfully eliminating the first listed risk factor previously discussed. By addressing gait problems before the patient ever falls, it is possible to decrease or eliminate two to four of the cited seven greatest risk factors.

While no medical profession can address and correct all seven listed risk factors, along with the numerous other potential risks, physical therapists clearly have the ability to correct, improve, impact, or guide treatment regarding the greater majority.

If, as argued, physical therapists are best positioned to reduce the frequency of falls by addressing the most modifiable risk factors, what are the most effective interventions that can be implemented? The American Geriatrics Society and British Geriatrics Society released an updated summary of clinical practice guidelines aimed at the prevention of falls in older persons [16]. The recommended approach to care and decision making for an older adult with a history of multiple falls, or an older adult with gait and balance deficits, is the completion of a multifactorial fall risk assessment. This type of assessment looks at a wide breadth of factors associated with falls to hone into each patient's individual deficits, and to create a specific and targeted intervention. Individuals with a single fall, or gait difficulties (rather than quantifiable gait deficits) did not statistically benefit from a multifactorial fall risk assessment and

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intervention.[3] Further evidence for this approach to fall prevention is supported within a 2012 Cochrane Review where multifactorial interventions successfully reduced the frequency of falls compared to other interventions.

The Missouri Alliance for Home Care has developed a fall risk assessment tool which has been validated for ability to accurately predict patient fall risk.[17] Table 1 shows the MAHC-10 (recreated for use within this case study – not intended to for use outside original purpose as released by the Missouri Alliance for Home Care). This assessment tool completed during initial evaluation of aging older adults can determine level of risk. Additionally, information gathered can assist in the creation of individualized treatment plans targeting patient deficits addressable by physical therapists directly, or as baseline objective measurement justifying medical referral. For complete understanding of patient's abilities in regard to independence, mobility, and function, physical therapists already collect much of the information in the assessment tool including patient history, specifically history of fall frequency and contributing factors related to falls such as the environment and situational factors prior to the fall and the complaints of pain or injury occurring after the fall. During the physical exam, the physical therapist assess the patient's feet in appearance and mobility. Addition functional assessment of gait, balance, perturbation correction, stability, use of assistive device and strength are collected, along with evaluation of condition and wear pattern of footwear. Pain, known as the fifth vital sign, is a subjective measurement collected from every physical therapy patient. Not only does the MAHC-10 use "pain affecting level of function" as a core element in their fall risk assessment tool, but additional studies point to the association between pain and mobility deficits, an often overlooked risk factor for falls [18]. Additional components of the multifactorial intervention that physical therapists would need to add when treating high fall risk patients to fully comply with multifactorial fall risk assessment would be a home visit. Collection and analysis of this information provides the ability to create an exercise program that addresses each modifiable area of patient fall risk.

Statistically, the probability of experiencing a fall seems inevitable. Despite the emergence of intervention plans and multifactorial fall risk assessments, elderly fall frequency has not slowed, demonstrating a disconnect between information availability and application in patient life. The purpose of this case study is to provide a rehabilitative framework to rectify objectively found patient specific deficits through the application of a previously developed exercise program in order to provide an all-encompassing fall prevention strategy that can be applied as part of normal physical therapy care.

Case Description

History

The patient followed throughout this case study was a 79 year old female living independently who presented to physical therapy with dizziness and unsteadiness. These symptoms have been occurring for multiple years, however, fall frequency has recently increased significantly. The patient reports experiencing over 50 falls in the past two months, none of which required a hospitalization.

This patient has undergone physical therapy in the past for similar concerns. A year prior to this case study episode of care, the patient fell backwards secondary to dizziness while walking up her garage stairs. This fall resulted in a severe concussion and hospital admission. After the hospitalization, the patient participated in six months of outpatient physical therapy. The physical therapy diagnoses was abnormal balance, weakness, and impaired function. Patient tested below normal in regard to gait speed, Timed Up and Go (TUG), Berg Balance scale, Dynamic Gait Index, Activities-specific Balance Confidence Scale (ABC), and 30 second sit to stand. Each test resulted in patient classification of significant fall risk. Upon discharge from this episode of care, the patient had met the goals of accuracy of Home Exercise Program (HEP) completion, fast gait speed improvement, Berg balance score, and sit to stand with use of upper extremities. However, the patient had not met goals for HEP compliance, comfortable gait speed, TUG, DGI for low fall risk and lower extremity strength and power. Discharge occurred secondary to plateau in progression.

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Current status

The patient's living situation during this case study episode of care is independent at home with intermittent assistance. Her daughter stays at the patient's home each night to ensure safety. A care giver is with the patient 3-4 hours three days a week. Information collected from caregiver includes increasing frequency of forgetfulness, confusion, and emotional tumult. The patient has recently been forced to give up driving her car. Although the patient is not ready to get rid of the car, she understands the risks driving would create to herself and to others. This has been a significant loss in the patient's life, resulting in feelings of further isolation and loneliness. The patient's goal is to not need as much support at home as she currently requires getting into and out of her house, cooking meals, navigating all surfaces, and taking part in community activities such as going to church, getting her hair done, and grocery shopping.

Clinical impression #1

The selected patient, at baseline evaluation, presents with 5 of the 7 risk factors for falling (history of falls, vertigo/dizziness, fear of falling, use of assistive device, and gait problems). [(2)] The first assessment completed was to rule out benign paroxysmal positional vertigo (BPPV) for the cause of her unsteadiness/dizziness symptoms. This Dix-Hallpike maneuver was negative for oscillatory nystagmus and symptom reproduction in all canal planes. Central nervous system tests for lesion at or around Vestibulocochlear nerve were completed and found within normal limits decreasing risk of underlying vestibulopathy as diagnostic cause. None of the patient's previous medical evaluations have indicated possible Meniere's Disease causing symptoms.

Outcome measures of the Dynamic Gait Index (DGI) and MiniBESTest were chosen to assess patient's current level of function in regard to independence in everyday tasks, objective fall risk, and obtain a list of deficits that physical therapy intervention could address and overcome. Additional baseline strength measurements were collected for functional muscle groups, along with assessment of the following functional activities: 30-second sit-to-stand, ambulation forward, retro, and lateral, heel walking, toe walking, balance, and stair navigation in accordance to the Otago Exercise Program[(15)]. Based on patient's age, gender, multiple comorbidities, existing risk factors for falls, cognitive deficits of confusion and forgetfulness, anticipated prognostic potential is fair to good. Factors leading to improved prognosis include current ability to live independently and motivation to continue living at home. Patient is dedicated to physical therapy, and sees it as a positive way to maintain independence while also receiving some much-needed social interaction.

Examination

Table 2 provides additional information pertaining to each Otago level of function. Levels for each exercise are the same as in the original Otago functional system, or slightly modified. The purpose of modification is to ensure that exercise had an objective and measurable baseline.

Table 3 presents all objective test measures collected prior to and following the intervention. The table supplies information regarding each test or exercise completed, testing conditions and the associated outcome assessment.

Clinical Impression #2

The Otago Exercise Program (OEP) to prevent falls in older adults is a research-based intervention protocol developed in 2003 for community dwelling older adults to reduce their risk of falls. Applied to multiple controlled trials, OEP benefits stem from the improvement of patient strength, balance, and confidence needed to successfully complete daily activities. This program is a one on one, individualized, home based exercise program implemented by physical therapists. Not only has this intervention been proven effective in reducing fall frequency[(1, 3, 6, 7, 14)] and injuries by 35%, it has also been found to have over 125% return on investment for patients over the age of 80 years old.[(6)] Table 2 provides additional information regarding each level's progressive difficulty and associated requirement standards for achievement. The original Otago scoring table presenting the level and

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number of repetition to be completed for strengthening and balance retraining protocol had multiple blank boxes leaving no way to grade the patient's baseline ability in each category. For example, Tandem Walk originally had no scoring criteria for Level A and B. To be able to determine the level of functional change, it was pertinent to establish measurable criteria for each level and each exercise. Minimal changes were made to bridge the functional gaps missing from the original table.

Barriers faced with implementation of this intervention start with the fact that OEP was designed to be an in-home intervention[15]. To overcome this obstacle a home visit was completed identify potential areas of vulnerability in the current home arrangement and suggest modifications. Modifications were made where able, and functional intervention strategies aimed to best prepare the patient to overcome each unmodifiable obstacle were incorporated into treatment. Therefore, although modified, the fundamental purposes of increasing strength and balance were thoroughly addressed without loss of interventional impact in an outpatient practice setting.

The use of the Dynamic Gait index during this intervention as an outcome measure was chosen because of its great interrater and intrarater reliability (ICC=0.82 and 0.89 respectively) and validity (r=0.76 with balance self-perceptions test, and r=0.67with Berg Balance Scale)[19]. Additional benefits of this test include its multiple functional activities that expose patient deficits at baseline to be addressed, its reproducibility, and the ability to complete the test with assistive devices per patient need. This test is widely used, and provides a strong objective measure of functional change. MCID and MDC are both established for adult population with risk of falls and vestibular deficits and can be found in Table 3.

The other main outcome assessment tool used to gauge intervention effectiveness was the MiniBESTest. While less widely used compared to the DGI, the MiniBESTest was found to provide additional information regarding anticipatory and postural corrective reactions, along with ability to maintain dynamic and static balance. Initially developed based on a combination of DGI, TUG, and the Berg Balance scale, this test provides a more complete view of individual deficits that lead to falls. The MiniBESTest has been validated[20], with MCID and MDC values calculated and presented in Table 3[21].

Intervention

Objective measurements were collected upon initial evaluation. These tests and their results ca be found in Table 3. Every test demonstrated that the patient had significant deficits in regard to strength, balance, and anticipatory response actions. Each are addressed throughout the intervention.

A total of 15 physical therapy visits were completed with this patient. Two treatment sessions occurred prior to the initiation of this case study. Treatment one included a baseline balance and gait analysis, and completion of basic lower extremity strength exercises (long arc quads, ankle pumps, heel raises, sit to stand, straight leg raise while standing into flexion, extension, abduction and adduction, standing marching, hamstring curls, heel raises, and toe raises). This session ended with patient education regarding posture, cues to improve efficiency of sit-to-stands, and a home exercise program. Treatment two included Dix-Hallpike maneuver and additional central nervous system tests (such as ocular range of motion exams looking for resting or end of range nystagmus, convergence tests, vestibulooccular reflex symptom provocation tests and the head thrust test). All test results were negative. Treatment three collected objective measures of the DGI, and the baseline components for Otago Exercise program intervention[15] (see table 3). Treatment four collected MiniBESTest objective information. Secondary to significant and concerning findings during the MiniBESTest collection, time was spent teaching compensatory stepping patterns to improve this area of deficit. Additional time was spent completing lower extremity strengthening per Otago intervention. Treatment five, and seven through fourteen, all spent time addressing balance, strength, postural reaction, and gait deficits. Balance interventions included practice standing with a variety of conditions including progressively more difficult challenges to vision (eyes open, eyes closed, looking left and right, looking up and down), standing base of support (narrow base of support, modified tandem, tandem, single leg support), and standing surface stability (firm, sloped, airex). Strength interventions included progressive intensity in number, weight, and time allowance for Otago Exercise Program specific tasks per OEP progression.

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Postural reaction interventions included anticipatory step training to teach patient to move feet upon loss of balance, rather than habitual grabbing for furniture, or tucking head for what the patient reported to be “inevitable” impact. Finally, gait training interventions focused, again, on Otago Exercise Program specific tasks, along with training to overcome unmodifiable obstacles found within the home, and throughout the community. An in home assessment was completed during treatment number six. Evaluation of patient’s home environment, functional abilities and areas of deficit occurred along with noting modifiable and unmodifiable obstacles the patient faces on a daily basis. Treatment number 15 was the final day of this case study intervention, where DGI, MiniBESTest, and all components of the Otago Exercise program were re-measured.

Outcome

All collected data from this intervention are presented in table 3. Notable changes include a six point improvement in DGI (MDC=2.9 points, MCID=1.8 points)[21], a fourteen point improvement in MiniBESTest (MDC=3.5, MCID=4)[21], and a change from unable to various degrees of independence in tasks such as ankle dorsiflexion, walking backward, walking sideways, walking tandem forward and backward, and sit to stand transfers without upper extremity assistance. Improvement occurred in knee extension, knee flexion, hip abduction, ankle plantarflexion, walking and turning around, tandem stance, single leg stance, number of sit to stands completed in 30 seconds, and stair navigation. The assistive device used, ability to complete toe walking, and heel walking all remained unchanged.

Discussion

Demand for fall prevention intervention is a universal need as falls affect aging individuals in every community, race, religion, gender and socioeconomic status. The cost and dangers of unaddressed fall risk cannot be overlooked.

The ideal healthcare professional to complete each aspect of fall risk is a physical therapist because of their comprehensive approach to patient care. Current physical therapy practice addresses most areas of the multifactorial fall risk assessment tools, along with consideration of comorbidities, medical conditions, and physiological barriers that can and will present further complication to implementation of successful fall prevention intervention. As every multifactorial fall risk intervention requires an exercise component, the profession of physical therapy can further demonstrate high expertise for teaching biomechanically appropriate movement patterns to optimize patient gait, balance, and strength.

Limitations of this study include the fact that results demonstrate success of one participant. This lack of power means the results are not generalizable to a larger population. Also, the intervention was applied in an outpatient practice setting although designed to take place in the home with a longer duration intervention period, and greater follow-up after intervention. Additionally, it is impossible to know whether it was the intervention itself that led to the improved objective measures, or whether some confounding variable was responsible for the change. Finally, this study presents the potential for biased measure improvements secondary to the functional nature of the MiniBESTest, Otago exercise tasks, and DGI assessment tool items. Positive results demonstrated following the intervention could simply be a “teach to the test” improvement resulting in performance advantages after the patient practices the task repeatedly across multiple intervention sessions.

The results of this case study present objective measurements demonstrating strength and functional activity improvement. These findings may suggest that the application of Otago exercise program as part of a multifactorial fall prevention intervention would reduce fall frequency among a wider population. Further research is needed to determine if the intervention presented in this case study can be successfully applied to a more general population while yielding similar positive results. Study replication would require a larger pool of highly variable subjects undergoing the presented intervention. Ideally, the larger sample would reach statistical power levels to improve generalizability of the study results. Additionally, a randomized sample with double blinded study parameters would help eliminate tester influence and bias.

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Table 1 - MAHC 10 – Fall Risk Assessment Tool.

Conduct a fall risk assessment on each patient at start of care and re-certification Patient name: _____ SOC or Re-certification Date: _____	
Required Core elements **Assess one point for each core element "yes"** *Information may be gathered from medical record, assessment and if applicable, the patient/caregiver. Beyond protocols listed below, scoring should be based on your clinical judgment.*	Points
Age 65+	
Diagnosis (3 or more co-existing) Includes only documented medical diagnosis	
Prior history of falls within 3 months An unintentional change in position resulting in coming to rest on the ground or at a lower level	
Incontinence Inability to make it to the bathroom or commode in timely manner Includes frequency, urgency, and/or nocturia.	
Visual Impairment Includes but not limited to, macular degeneration, diabetic retinopathies, visual field loss, age related changes, decline in visual acuity, accommodation, glare tolerance, depth perception, and night vision or not wearing prescribed glasses or having the correct prescription	
Impaired functional mobility May include patients who need help with IADLS or ADLS or have gait or transfer problems, arthritis, pain, fear of falling, foot problems, impaired sensation, impaired coordination or improper use of assistive devices.	
Environmental hazards May include but not limited to, poor illumination, equipment tubing, inappropriate footwear, pets, hard to reach items, floor surfaces that are uneven or cluttered, or outdoor entry and exits	
Poly Pharmacy (4 or more prescriptions – any type) All PRESCRIPTIONS including prescriptions for OTC meds. Drugs highly associated with fall risk include but not limited to, sedatives, anti-depressants, tranquilizers, narcotics, antihypertensives, cardiac meds, corticosteroids, anti-anxiety drugs, anticholinergic drugs, and hypoglycemic drugs.	
Pain affecting level of function Pain often affects an individual's desire or ability to move or pain can be a factor in depression or compliance with safety recommendations.	
Cognitive impairment Could include patients with dementia, Alzheimer's or stroke patients or patients who are confused, use poor judgement, have decreased comprehension, impulsivity, memory deficits. Consider patients ability to adhere to the plan of care	
A score of 4 or more is considered at risk for falling **Total**	

https://www.homecaremissouri.org/projects/falls/documents/Oct2012FINALValidatedFallriskassessmenttool.pdf

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Table 2. Modified Otago Exercise Program with Level assignment and quantification requirements [Based on Original (15)]

Strengthening Exercises					
		Level A	*Level B*	*Level C*	*Level D*
1	Knee extensor (front knee strength)	<10 repetitions with support	10 repetitions With support	10 repetitions No support	10 repetitions No support; Repeat
2	Knee flexor (back knee strength)	<10 repetitions with support	10 repetitions With support	10 repetitions No support	10 repetitions No support; Repeat
3	Hip Abductor (side hip strength)	<10 repetitions with support	10 repetitions With support	10 repetitions No support	10 repetitions No support; Repeat
4	Ankle plantarflexors (calf raises)	<10 repetitions with support	10 repetitions With support	10 repetitions Hold support; Repeat	10 repetitions No support; Repeat
5	Ankle dorsiflexors (toe raises)	<10 repetitions with support	10 repetitions With support	10 repetitions Hold support; Repeat	10 repetitions No support; Repeat
Balance Retraining Exercises					
		Level A	*Level B*	*Level C*	*Level D*
1	Knee Bends	10 repetitions Hold support	i) 10 repetitions no support or ii) 10 repetitions, hold support, repeat	10 repetitions No support, repeat	3x10 repetitions No support
2	Backwards walking	i) Achieve 0-10 steps; Hold support; 0-4 times ii) Unable to attempt	10 steps, 4 times, Hold support	Achieve 0-10 steps No support; 0-4 times	10 steps, 4 times, No support
3	Walking and turning around	Walk and turn around (make figure of 8) Use of walking aid Require sitting break before second attempt	Walk and turn around (make figure of 8) twice Use of walking aid	Walk and turn around (make figure of 8) twice No support	Walk and turn around (made figure of 8) twice No support Complete in < 10 seconds
4	Sideways walking	i) Achieve 0-10 steps Hold support; 0-4 times ii) Unable to attempt	10 steps, 4 times Use of walking aid	Achieve 0-10 steps No support 0-4 times	10 steps, 4 times No support
5	Tandem stance (heel toe stand)	10 seconds Hold support	10 seconds No support	20 seconds No support	>30 seconds No support
6	Tandem walk (heel toe walk)	0-10 steps Hold Support	Walk 10 steps Hold support Repeat	0-10 steps No Support	Walk 10 steps No support Repeat

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Table 2 cont'd. Modified Otago Exercise Program with Level assignment and quantification requirements [Based on Original (15)]

		Level A	*Level B*	*Level C*	*Level D*
7	One leg stand	<10 seconds Hold support	10 seconds Hold support	10 seconds No support	30 seconds No support
8	Heel walking	i) Achieve 0-10 steps Hold support 0-4 times ii) Unable to attempt	10 steps, 4 times Hold support	Achieve 0-10 steps No support 0-4 times	10 steps, 4 times No support
9	Toe walk	i) Achieve 0-10 steps Hold support 0-4 times ii)Unable to attempt	10 steps 4 times Hold support	Achieve 0-10 steps No support 0-4 times	10 steps, 4 times No support
10	Heel toe walking backwards	i) Achieve 0-10 steps Hold support ii) Unable to attempt	10 steps Hold support	0-10 steps No support	Walk 10 steps No support
11	Sit to stand	5 Stands 2 hands for support	i) 5 stands One hand support ii) 10 stands Two hands for support	i) 10 stands; No support ii) 10 stands 1 hand for support Repeat	10 stands; No support Repeat
12	Stair walking	Unable to Navigate 4 standard stair height without Moderate to Maximum assist	Navigate 4 standard stair height Two hand rail support	Navigate 4 standard stair height One hand rail support Repeat	Navigate 4 standard stair height No hand rail support Repeat

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Table 3. Examination Findings.

Test	Testing conditions	Initial Findings	Discharge findings	Outcome assessment relation and functionality
DGI	With Rolator Walker	11/24	17/24	MDC 2.9 MCID 1.8
MiniBEST	With Rolator Walker	2/28	16/28	MDC 3.5 MCID 4
Knee extensor	Seated	10 (Level B)	25 x2 (Level D)	Otago
Knee flexor	Standing with B UE support	8 w/ B UE support (Level A)	25 x 2 w/ unilateral UE support (Level C)	Otago
Hip abductor	Standing with B UE support	8 (Level A)	25 x2 w/ unilateral UE support (Level C)	Otago
Ankle plantar flexors	Standing with B UE supoort	5	15 x2	Otago, MiniBest
Ankle dorsiflexors	Seated	0	15 x 2	Otago
Backward walking	40 feet – firm, straight, unobstructed	Unable	Independent, rollator	Otago
Walking and turning around	40 feet – firm, straight, unobstructed	CGA w/ rolator walker	Independent, Rollator	Otago DGI MiniBest
Sideways walking	40 feet – firm, straight, unobstructed; patient use walker or B therapist assist	Unable	Mod assist by SPT via HHA	Otago Minibest
Tandem stance	Standing, firm surface	3 sec, modified stance	20 sec	Otago
Tandem walk	40 feet – firm, straight, unobstructed	Unable	Independent, 10 steps with rollator walker	Otago
Single leg stance	Firm with UE support as needed for safety	<3 seconds with B UE	10 sec with unilateral UE	Otago MiniBest
Heel walking	40 feet – firm, straight, unobstructed	Unable	Unable	Otago
Toe walk	40 feet – firm, straight, unobstructed	Unable	Unable	Otago
Retro tandem walking	40 feet – firm, straight, unobstructed	Unable	Independent 10 steps with Rollator	Otago
Sit to stand	Chair with arm rests	5 with 2 hand support 0 without UE	11 with 2 hand support 2 without UE	Otago MiniBest
Stair walking	Curb step or 5 successive steps	Curb Step with max assist and rollator	3 stairs with 2WW x 3 with SBA	Otago DGI MiniBest

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